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SHRINKAGE AND GRADE OF WHEAT STORED IN COUNTRY ELEVATORS IN KANSAS

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PREFACE

In recent years research workers at Kansas State College have been studying the numerous aspects of analysis of costs relating to short and long term storage of wheat. Previous publications have provided extensive information on most important fixed and variable costs. In the spring of 1955 a project was initiated to determine the costs of shrinkage and quality changes in stored wheat, two costs about which there was a definite lack of knowledge.

An analysis of these costs for storage of wheat in Commodity Credit Corporation bin-sites will be summarized in a separate report.

Funds were made available for analysis of these costs of grain marketing through a contract between the United States Department of Agriculture and the Agricultural Experiment Station of Kansas State College of Agriculture and Applied Science.

The authors wish to acknowledge the assistance and cooperation of the operators of grain elevators in obtaining the extensive data for the study.

Acknowledgment is made to William C. Dachtler and V. John Brensike of the Agricultural Marketing Service, U. S. Department of Agriculture, and to John H. McCoy, Associate Professor, and Leonard W. Schruben, Professor, of the Department of Agricultural Economics, Kansas State College, for general direction in the planning and completion of the study.

The study is part of a broad program of research to improve the marketing of farm products.

CONTENTS

	Page
Preface	2
Summary	3
Methodology	4
Physical shrinkage	7
Grade changes	11
Differences in operating practices and conditions	11

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SHRINKAGE AND GRADE OF WHEAT STORED IN COUNTRY ELEVATORS IN KANSAS

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SUMMARY

Shrinkage. In one-third million bushels of 1952, 1953, and 1954 wheat stored in country elevators in Kansas, shrinkage averaged about one-fourth of 1 percent of the gross weight of the wheat. In this report gross or physical shrinkage corresponds with net or market shrinkage only with respect to "zero dock" wheat. Shrinkage resulted primarily from (1) loss of moisture during a storage period which averaged $10\frac{1}{2}$ months, and (2) loss of small particles removed or blown into the air in the weighing and turning operations during storage. These losses could not be measured separately, but the total loss reflects, at least in part, the influence of these factors.

The cost of the shrinkage loss, if it is valued at $2.00 a bushel, averaged about one-half cent per bushel.

Twenty-one observations were made on shrinkage in wheat stored in 11 different country elevators located in the western two-thirds of Kansas.

The individual shrinkage observations varied from a low of 0.08 percent to a high of 0.42 percent of the weight of the wheat, or from 0.8 bushel to 4.2 bushels for every 1,000 bushels stored. The weighted average shrinkage for 21 observations was found to be 0.26 percent, or 2.6 bushels for every 1,000 bushels stored.

Shrinkage losses per elevation of the wheat varied from a low of 0.03 percent to a high of 0.21 percent, or from 0.3 bushel to 2.1 bushels for every 1,000 bushels elevated. The weighted average shrinkage was 0.13 percent per elevation, or 1.3 bushels for every 1,000 bushels elevated.

A significant difference was noted between average shrinkage for the 1954 wheat and the older wheat from the 1952 and 1953 crops. The average shrinkage for the 1954 wheat was 1.8 bushels per 1,000 bushels stored. This was substantially less than the 2.7 bushels for the 1953 wheat and the 3.1 bushels for the 1952 wheat.

Grade. No changes in grade occurred in the wheat under observation. Although loss in grade is a risk in storing grain, the results of this study would seem to indicate that this factor is not of any great significance in normal operations of country elevators.

Only one compartment of wheat had any substantial insect infestation. Although no grade loss was noted for the wheat in this particular compartment under the official grading system now in use, more extensive milling and baking tests might have shown some deterioration in quality. However, from a grain merchandising point of view only the grade changes need to be considered.

Operating factors. Elevator operators seemed to rely on their own experience and judgment as to when quality maintenance practices, such as turning operations and fumigations, should be carried out. A rather wide variation in practices was the result.

The significantly lower losses in the 1954 crop wheat than in the older crop wheat, indicates that shrinkage losses tend to increase with each successive elevation. Investigation into the number of turning operations that are really necessary for proper maintenance of storage stocks would seem to offer possibilities of economies.

The management practices which probably are the most important in reducing shrinkage and loss in grade are (1) storage of wheat low in moisture, (2) elevation of grain as few times as necessary for inspection and quality maintenance, (3) prevention of insect infestations, including proper fumigation of all grain brought from other types of storage, (4) use of the most economical type of dust collection system, and (5) refraining from dropping the grain through the driveway to the elevator pits.

METHODOLOGY

Estimates of shrinkage losses in grain elevators have been made by operators for accounting and taxation purposes. These estimates have been primarily based upon judgment rather than specific experimental evidence. Losses for a particular year's operation have been obtained, but such information covers losses between loading in and delivery to market facilities. Such estimates cover a multitude of loss possibilities. In such instances losses may be high or low depending on such factors as scale accuracies and intransit losses during rail shipment.

Accurate data have not previously been available on the actual turning and storage losses. A recent U. S. Department of Agriculture publication states that "....from general information available and from specific existing records a weight... loss of one-fourth of 1 percent in handling or merchandising appears reasonable under good management. An additional figure of one-fourth of 1 percent for this loss during storage is used." 1/ This would estimate annual loss as one-half of 1 percent per bushel handled and stored.

1/ Hall, Thomas E., Davis, Walter K., and Hall, Howard L. New Local Elevators, Cost-Volume Relations in the Hard Winter Wheat Belt, U. S. Dept. Agr., Farmer Cooperative Service, Service Report No. 12, May 1955, p. 57.

Due to the inadequacy of data on shrinkage, it is not generally shown as a separate cost item, although total costs may actually include shrinkage if fewer units are sold than were purchased. Its effect would then be shown by a lower gross margin. It is of value to know and account for this loss as such in computing total costs of handling and storing grain.

The purpose of this portion of the study was to determine weight losses in turning and storage operations in local country elevators and to obtain information on the costs involved. It was felt that valid information could be best obtained by selecting compartments of wheat and holding them in isolation for a period of time. The wheat would be weighed before and after each storage period.

A record of management practices was kept on each bin under study. The factors of most importance were (1) the type of dust collection system in use, (2) the number of fumigations to control insect outbreaks, (3) the system used in elevating wheat (that is, whether grain was dropped through driveway or channeled directly to the leg for elevation to the head house), (4) wheat grade, dockage, and moisture content, and (5) record of previous turnings and fumigations.

Since extra time and expense were required to measure shrinkage at country elevators the sample used in this study was obtained by locating operators who were interested in the problem. Operators of 22 different country elevators located in the western two-thirds of Kansas agreed to conduct the study with 31 separate compartments of wheat. Each elevator facility under observation was of slip-form concrete construction since this is the major type of grain storage structure in use today. Some of the observations were not successful because of problems involved in accurate weighing and isolation of the wheat for extensive periods of time. Complete and accurate measurements of shrinkage were made on 21 compartments of wheat located at 11 different elevators.

Wheat from the 3 crop years, 1952, 1953, and 1954, was placed under observation. Of the final observations, 6 were made with wheat from the 1954 crop, 8 from the 1953 crop, and 7 from the 1952 crop.

At initiation of the study each compartment of wheat was weighed on the loading-out scale used at the elevator. The gross weight of the wheat was recorded. The wheat was then delivered to a compartment for storage. The identity of the wheat in each compartment was preserved during and between turning and weighing operations. This was done by closing the compartment and designating gates and spouts to reduce the possibility of adding or removing wheat by mistake. Because accuracy is needed to determine shrinkage, it was absolutely necessary that no grain be added or removed during the period under observation.

Each compartment of wheat was weighed periodically depending on the operator's usual turning practice.

The wheat under observation in this study in general was representative of wheat normally stored by country elevators in Kansas.

Moisture content at the beginning of the period of observation ranged from 9.3 percent to 11.9 percent, as shown by official inspection of representative samples of the wheat in the 21 compartments. The average moisture content was 10.3 percent. Country elevator operators generally prefer not to accept wheat for storage which has a moisture content greater than a maximum which they consider safe for storage. All of the wheat included in this study was well below the maximum moisture content levels generally acceptable to country elevator operators.

Inspection certificates showed zero percent damaged kernels for all compartments. Only one compartment was shown as having foreign material (the amount in that case was 1 percent). The grade designation for one compartment carried the word "weevily."

Dockage, as shown by the samples taken at the beginning of the period of observation, was less than 2 percent for all compartments and less than 1 percent for all but 3 compartments. The grade designation thus showed 1 percent dockage for 3 compartments and zero dockage for the remaining. 2/

Comparison of shrinkage observed for the 21 compartments was made as follows: As the wheat was moved from compartment to compartment, it was elevated to a weighing device, and a record was kept of the gross weight. In normal storage operations the wheat is moved directly from one compartment to another without going through a weighing device. However, in order to determine shrinkage it was necessary to move the wheat through a scale to weigh the grain. In all instances this required one or more extra elevations of the wheat.

If dockage is present in wheat, the grain trade in its normal operations records the "net" weight of wheat, which is computed by subtracting from the gross weight the weight computed from the percent (expressed in whole numbers) of dockage present. This stems from the way wheat is handled under the grain standards. 3/

Accuracy in the measurement of shrinkage, however, could be obtained only if the computations were made on the basis of changes in "gross" weight rather than changes in "net" weight even though 3 of the compartments of wheat included in this study contained small amounts of dockage.

Computation of physical shrinkage on the "gross" basis involves error if the rate of shrinkage in the wheat kernels is greater or less than in the dockage.

2/ According to the Official Grain Standards of the United States, June 1957: The percentage of dockage when equal to 1 percent or more, shall be stated in terms of whole percent, and when less than 1 percent shall not be stated. A fraction of a percent shall be disregarded.

3/ See footnote 2.

In wheat which contains less than 2 percent dockage 4/ (as in this study), a different rate of shrinkage in the dockage part of the "wheat" could have had comparatively little effect on the rate of shrinkage for the total mass of "wheat." Chances of error in measuring shrinkage on the gross weight basis are less than those involved in net computations which require: (1) Taking samples from which the percent of dockage is determined and (2) disregarding fractions of a percent of dockage found in those samples. 5/

Gross or physical shrinkage as determined in this study corresponds to net or market shrinkage only for "zero dock" wheat. Three of the 21 compartments contained dockage under the Offical Grain Standards terminology, and an analysis of the relative levels of gross shrinkage in these 3 compartments indicates that they were comparable to the gross shrinkage in compartments containing "zero dock" wheat (table 1). This comparability in gross shrinkage was recorded even though official grain samples indicated that the dockage in each of these 3 compartments appeared to decrease by as much as 0.9 percent. 6/

Grade was measured by official inspection of a representative sample of the wheat in each compartment during each turning and weighing operation. The official grades at the beginning of the study and at the final weighing of each compartment were compared to determine whether any change in grade had occurred.

PHYSICAL SHRINKAGE

Physical shrinkage of the wheat in each compartment is represented by the difference between the weight placed in the compartment and the weight removed after a given period of storage. As shown in table 1, gross shrinkage in individual lots ranged from 0.08 percent to 0.42 percent. The value of shrinkage ranged from 0.16 to 0.84 cent per bushel. For each 1,000 bushels weighed into a compartment, shrinkage ranged from a low of 0.8 bushel to as high as 4.2 bushels, or from $1.56 to $8.45 in value.

4/ Zero dockage in 18 compartments and 1 percent dockage in 3 compartments, using Official Grain Standards terminology.

5/ Sampling bias and disregard of fractions becomes an especially difficult problem when the amount of dockage actually in the wheat is close to a percentage break point. If the sample taken at the beginning of the storage period, for example, showed 0.94 percent dockage and the sample taken at the end of the period showed 1.05 percent dockage, computation on the "net" basis would include "shrinkage" of 1 percent which was due entirely to sampling bias and disregarding fractions. When shrinkage computed on gross weights averaged only one-fourth of 1 percent (as it did in this study), a "net" basis of computation, which injects the possibility of increasing or decreasing "shrinkage" by a whole percent in any one bin, had to be rejected.

6/ In these 3 compartments the initial gross weights are reduced by 1 percent to get the net or market weight of the wheat. At the end of the study, these compartments were "zero dock" and no dockage reduction is necessary. Accordingly there would be an increase in the "net" weight of the wheat of an amount equal to 1 percent minus the shrinkage shown in table 1.

Table 1.--Physical shrinkage of 21 lots of 1952, 1953, and 1954 wheat stored in country elevators in Kansas and length of storage during study

Crop year, and elevator number and compartment	Shrinkage during study	Shrinkage per elevation [1]	Storage during study
	Percent	Percent	Days
1952 wheat:			
1 A	0.1695	0.0848	103
2 [2] B	.2319	.1159	201
2 B	.4224	.2112	349
3 A	.3768	.1884	506
3 B	.3368	.1684	254
3 B	.3971	.1986	506
4 A	.0990	[3] .0330	151
1953 wheat:			
7 A	.1031	.0516	1
7 A	.2781	.1391	193
8 A	.1612	.0806	277
8 A	.3567	.1783	362
9 [4] A	.0778	.0389	384
10 A	.3607	.1804	436
11 [5] B	.1539	.0770	511
13 A	.3304	.1652	188
1954 wheat:			
21 A	.1639	.0820	373
21 A	.1935	.0967	161
2 A	.1910	.0955	200
7 B	.1310	.0655	203
8 B	.1889	.0944	363
11 A	.0937	.0468	511

1/ Each lot elevated 2 times except 1 lot elevated 3 times.
2/ Sample dockage into storage, 1.10; out of storage, 0.90 percent.
3/ Elevated 3 times.
4/ Sample dockage into storage, 1.60; out of storage, 0.81 percent.
5/ Sample dockage into storage, 1.70; out of storage, 0.81 percent.

The figure used for the value of the loss through shrinkage was $2.00 per bushel. This figure was used for ease of computation and because it is representative of the average price received by Kansas farmers for the 1956-crop wheat marketed during 1956-57. The average value of this gross shrinkage which is applicable to net or market shrinkage for "zero dock" wheat amounted to $5.16 for each 1,000 bushels of wheat stored.

The shrinkage observed in this study included losses in weight during the storage period and during turning operations. Losses during storage appear to result primarily from loss of moisture, and losses during turning operations appear to result primarily from loss of the smaller particles which are lost or blown into the air. No separate measure could be made of shrinkage losses by cause of the loss or by time of the loss, but the total loss reflects, at least in part, the influence of these factors.

The moisture content of the samples indicated some loss in moisture during the storage period. Samples taken at the beginning of the storage period showed an average moisture content of 10.3 percent; at the end of the storage period, samples averaged 10.2 percent moisture. Approximately one-half of the bins showed decreases in moisture content, one-fourth showed no change, and one-fourth showed increases in moisture content, according to tests made on the samples.

The largest decrease in moisture, as shown by the samples, occurred at elevator No. 4 where the moisture content was 10.7 percent at the beginning and 9.4 percent at the end of the storage period. Undoubtedly sampling bias contributed to this apparent decrease, as gross weights actually showed the percent shrinkage to be one of the lowest observed in this study.

The largest increase in moisture, according to the samples, occurred at elevator No. 13 where moisture content was 9.5 percent at the beginning and 10.3 percent at the end of the storage period.

At elevator No. 7 the first observation showed a shrinkage loss of 0.05 percent per elevation. This wheat was held in storage only one day between weighing operations. The second observation, with about 200 days in storage between weights, indicated a loss of nearly 0.14 percent per elevation. This indicates that part of the shrinkage loss occurred during storage and part occurred during the turning operation itself.

While these observations seem to indicate that the shrinkage losses are due, at least in part, to losses in moisture, statistical analyses failed to show any significant relationship between gross shrinkage and moisture losses or length of storage period.

The length of storage between weighings ranged from 1 day to as much as 511 days and averaged 10½ months.

When shrinkage losses were separated according to practices associated with turning operations, however, some significant differences were noted.

Shrinkage losses per elevation were used for these comparisons. The individual observations of losses per elevation are shown in table 1. Shrinkage losses under different management practices are discussed in detail in the section on operating practices.

Shrinkage per elevation ranged from a low of 0.03 percent to a high of 0.21 percent. For each 1,000 bushels of wheat this amounts to a shrinkage loss of 0.3 bushel to 2.1 bushels per elevation.

The weighted average shrinkage per elevation was 0.13 percent for the 21 observations or 1.3 bushels for every 1,000 bushels elevated.

Shrinkage of wheat under observation from the 1954 crop was considerably lower than that noted for older crop wheat (table 2). Shrinkage losses for 1954 crop wheat averaged only 1.8 bushels per 1,000 bushels stored while 1953 wheat averaged 2.7 bushels and 1952 wheat averaged 3.1 bushels per 1,000 bushels stored.

Table 2.--Average physical shrinkage, by year of harvest, of 1952, 1953, and 1954 wheat stored in country elevators in Kansas

Crop year	Average number of elevations per lot prior to study	Shrinkage	Shrinkage per elevation during study 1/
	Elevations	Percent	Percent
1952	8	0.3135	0.1463
1953	7	.2733	.1367
1954	3	.1775	.0887
Average	-	.2582	.1261

1/ Included 2 elevations in all cases except for 1 elevator with 3 elevations.

Thirteen of the compartments were large round concrete tanks with storage capacities ranging from 18,295 to 27,671 bushels. Eight compartments were small overhead or interstice bins with storage capacity of 2,950 to 6,200 bushels. Wheat stored in the smaller compartments had a smaller shrinkage loss than that in the larger compartments. The 8 smaller compartments had 0.08 percent shrinkage per elevation while the 13 larger compartments had 0.14 percent shrinkage per elevation. The cost of this physical shrinkage of $2.70 per 1,000 bushels elevated for the wheat stored in the large compartments appears to be significantly larger than the cost of $1.63 per 1,000 bushels elevated in the smaller compartments. However, the larger compartments contained more of the 1953 and 1952 wheat than did the smaller compartments. The crop year of the wheat stored was probably a greater factor than the size of compartment in bringing about the above results.

GRADE CHANGES

Official grain inspection certificates were obtained on samples of the wheat selected at each turning and weighing operation. No change in grade occurred in the 21 compartments during the study.

Two factors point out why quality deterioration of wheat in storage in country elevators in Kansas appears to be unimportant. (1) Equipment is available and is utilized to mix different grades of wheat and thereby hold it with relative ease within certain ranges of test weight. (2) Grading factors used are primarily test weight, moisture, dockage, and foreign material. Although these are the grading factors now used, actual quality deterioration might best be measured by milling and baking tests. It is possible that if more detailed tests had been used some quality deterioration might have been detected.

DIFFERENCES IN OPERATING PRACTICES AND CONDITIONS

The results of this study indicate that the shrinkage losses resulted from (1) loss of moisture during storage and (2) other losses during the turning operations.

Analysis of the shrinkage losses associated with different operation practices and conditions during turning showed some significant differences.

For these comparisons shrinkage losses per elevation were computed. All compartments except 1 were elevated twice to obtain the 2 weights for the shrinkage estimate. Comparison of shrinkage per elevation was made for two reasons: (1) One compartment was elevated 3 times. (2) In normal elevator operations wheat is turned directly from one compartment to another, and thus the extra elevation to obtain weight is not made. For comparison of management practices it was necessary to compare shrinkage per single elevation since this is the normal turning operation.

The standard means of maintenance of quality in wheat stored in country elevators is to elevate and aerate the grain periodically. Elevator operators do not turn wheat in storage any standard number of times during any given period of time. Some operators follow the practice of turning as many as 8 to 10 times or even more in a year. Others may turn only 1 or 2 or 3 times in a year. One or two turnings annually were found to be the practice most often used.

Shrinkage of wheat from the 1954 crop was significantly lower than that noted for the 1953 crop, and losses for the 1953 crop in turn were lower than for the 1952 crop. Such results indicate that shrinkage tends to increase with each successive elevation. The 1952 and 1953 wheat, because it had been in storage longer, had been turned and elevated oftener. Although there is considerable variation in the number of times wheat is turned for inspection and

quality maintenance, in a representative situation wheat would be turned 1 or 2 times a year after the first season in storage. At initiation of the study 1952 wheat delivered to the elevator at harvest had been turned and elevated an average of 8 to 10 times, 1953 wheat an average of 7 times, and 1954 wheat an average of only 3 times.

Apparently shrinkage losses increase with each successive elevation of abrasive action of the wheat mass moving against spouting and concrete walls. The lower shrinkage for the 1954 wheat thus appears at least partially attributable to the fact that it had been elevated fewer times.

The importance of the shrinkage cost data obtained in this study, although it appears to be small, can best be shown when it is applied to a normal elevator operation. For example, an elevator with 300,000 bushels total capacity may be assumed to utilize 250,000 bushels for wheat storage. During the second year in storage, shrinkage costs at the rate observed in this study for 1954 wheat would be about 0.18 cent per bushel per elevation. Using 2 rotations or elevations of storage stocks annually, the total costs attributable to gross shrinkage alone would amount to $887.00. During the fourth year of storage with 2 elevations per year, costs at the rate observed in this study for 1952 wheat would amount to $1,567.50 annually. When more than 2 elevations per year are normal practice, shrinkage costs would rise accordingly.

With an average cost of nearly one-fourth of a cent per bushel per elevation, a 4-year storage program with 2 complete rotations of storage stocks annually would cost approximately 2 cents per bushel for shrinkage losses alone. Although this figure alone is not as important as certain other costs associated with long-term wheat storage, it is by no means insignificant. Investigation into the number of turning operations that are really necessary for proper maintenance of storage stocks would seem to offer possibilities of economies.

During movement of grain, a considerable amount of dust is present. Such dusty conditions constitute a hazard to the health of the individual operating the facility and are a fire and explosion hazard. For these reasons most elevator facilities use some type of dust collection equipment. Primarily three types of dust collection systems are in use at country elevators in Kansas. These are (1) use of fans to blow the dust from moving equipment directly into the air, (2) collection of the dust in a specific compartment from which it is later removed and destroyed or used as livestock feed, and (3) use of fans and collection equipment to remove the dust and hold the larger particles for replacement into the grain stream.

When the larger particles are returned to the grain stream, somewhat lower shrinkage would be expected than when all particles are completely removed. Table 3 shows that this was found to be true under actual operating conditions. The average gross shrinkage for the wheat at elevators that collected the larger particles and returned them to the grain stream was 0.086 percent per elevation. When none of the particles were returned to the wheat, average shrinkage was 0.136 percent.

Table 3.--Average physical shrinkage, by method of handling dust, of 1952, 1953, and 1954 wheat stored in country elevators in Kansas

Method of handling dust	Shrinkage	Shrinkage per elevation during study
	Percent	Percent
No particles of dust returned to grain stream	0.2805	0.1362
Larger particles collected and returned to grain stream	.1720	.0860
Average	.2582	.1261

During elevation of the wheat from 8 of the compartments the grain was dropped from the compartment through the truck driveway into the pits. This method is primarily used where spouting equipment is not available to deliver the wheat directly to the elevating mechanism. In some instances this operation is conducted in an attempt to cool or to dry grain.

A disadvantage of this type of operation is the amount of breaking and grinding action which results. A free fall of 20 to 30 feet culminating in striking the type of grate used in country elevators can be expected to cause breakage of the wheat kernels. This tends ultimately to increase the amount of dust, some of which is lost as shrinkage. Usually, a box, barrel, or other object was placed over the grate to reduce the force of the fall and thereby reduce the amount of breakage and grinding action.

None of the 1952 wheat was dropped through the drive during turning operations but this practice was carried out on all of the 1953 wheat. Two of the 6 compartments of 1954 wheat were dropped through the drive. Adequate analyses could not be made because sufficient amounts of each year's wheat were not elevated in the same manner.

Records were also maintained on insect infestations, fumigations, and use of insecticides. These are all important in proper maintenance of storage stocks of wheat. Their importance in influencing shrinkage, however, is measurable only under detailed experimentation.

Insect infestations in stored grains constitute a hazard to maintenance of quality. In normal elevator operations, however, only a severe infestation not detected for a substantial length of time would result in any significant loss in grade. Where severe infestations have been found in wheat stored in country elevators, little loss in quality has actually resulted. This is again due to the opportunity of mixing and turning grain to remove odor and other evidences of insect action. Only one compartment of wheat was noted to have had any severe insect infestation and this problem was solved with no change in grade. Shrinkage losses could be increased by a substantial amount of insect action.

Fumigation practices were found to vary considerably between operators. Most operators follow some standard set of rules concerning time of fumigation and use of fumigants. Fumigation practices were of five general types. (1) Some operators fumigated the grain each time it was turned. (2) Others fumigated during the pre-winter turning operation and then fumigated at other turning operations only if insects were found. (3) Some did not fumigate at all after the first year of storage unless it was necessary to control an insect infestation. (4) When small overhead and interstice compartments were used, some operators fumigated during turning operations and during the summer months between turning operations by pouring the fumigant into the top of the compartment. (5) Some operators sprayed insecticides on the walls of the compartments before filling them with wheat.

There is no doubt that in some elevators the stored wheat has lost quality. Yet, as was evident from this study, quality maintenance was very successful for 1952, 1953, and 1954 wheat stored in concrete structures in Kansas. Although there is an ever-present risk of loss in grade, no evidence was revealed in this study that quality loss is significant in the long-term storage of wheat under the conditions and in the structures observed.

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